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ANALYSIS OF THE PHYSICAL AND PHYSICO-CHEMICAL PROPERTIES OF OIL EXTRACTED FROM CASHEW KERNELS (*ANACARDIUM OCCIDENTALE*) FROM BOUAKE, IN CENTER OF CÔTE D'IVOIRE

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ABSTRACT

This study aims to highlight the physical and physicochemical properties of oil extracted from cashew nut kernels from central Côte d'Ivoire. The oil extracted from *Anacardium occidentale* kernels in the city of Bouaké was characterized. The physical parameters were evaluated using appropriate devices and the dosage was carried out using a spectrophotometer. Then, the physicochemical characteristics were determined by classical methods of dosage. The results show that *Anacardium occidentale* oil has the refractive index (Ir = 1,464 ± 0,025), density (0,901 ± 0,016), specific extinction coefficients K_{232} (2,510 ± 0,007) and K_{270} (0,205 ± 0,012). The physicochemical analysis allowed to identify the indices of saponification (Is = 391,297 ± 0,461), iodine (Ii = 90,691 ± 0,743), acid (Ia = 9,537 ± 0,252), peroxide (Ip = 5,133 ± 0,090) and ester (Ie = 381,760 ± 1,029). In view of the physical and physicochemical properties of *Anacardium occidentale* oil, it is relevant to consider the integration of this plant among those regularly used for the production of edible and pharmacological oil.

KEYWORDS: *Anacardium occidentale*, fat, physicochemical properties; physical properties, Côte d'Ivoire.

1. INTRODUCTION

Anacardium occidentale, also called "cashew" or "cashew", can be grown for its fruiting or for reforestation depending on climatic conditions (**Figure 1**). Its lifespan is about 30 years and cashew production in Côte d'Ivoire extends from February to June. When the cashew nut reaches a maximum size (30 to 35 days), the peduncle begins to develop considerably and rapidly. These two fruits reach maturity at the same time (Lautié et al, 2001).[1] The cashew nut, when mature, is gray or gray-brown in color, kidney-shaped, measuring on average 2.7 cm long by 2,1 cm wide and 1.6 cm thick. Its weight varies from 3 to 10 g, on average 5 g, but can reach 20 g in Brazil (Lautié et al, 2001).[1] In recent decades, Côte d'Ivoire has experienced a huge increase in cashew nut production.

Figure 1: a) Cashew tree, b) cashew fruits.

The country has become the world's leading producer, increasing from 8,500 tonnes in 1989 to over 70.000 tonnes in 1999 and then to 350.000 tonnes in 2010 (Dugué, 2002; Koné, 2014; World Bank, 2015).[2,3,4] Despite the drought of 2016 and clandestine sales to Ghana, production officially exceeded 700.000 tonnes in 2017. The different parts of the cashew tree and its oil are widely used in traditional African medicine with numerous applications listed in the African pharmacopoeia (Eugène Ucciani, 1995; J-L Pousset, 2004).[5,6]

Figure 2: c) Cashew nuts, d) dried almonds.

The cashew nut kernels, obtained after shelling (Figure 2), are consumed salted or spicy, and used in the food industry for making cakes, chocolate, ice creams, etc. They are also used to prepare cashew butter. Recent studies on the kernels of nuts from central Côte d'Ivoire have shown a richness in macronutrients, with an average fat content of 21-22% (Katou et al., 2023)[7], as well as in micronutrients (polyphenols, tannins, flavonoids) and minerals (Katou et al., 2024).[8] The plant contains many medicinal properties, including the removal of warts, the cure of leprosy, the fight against cancer, and antiseptic properties (Soro, 2008).[9] The oil is traditionally used in food and for its skin regenerative effects (J-L Pousset, 2004).[6] Despite these common uses, few scientific studies have been devoted to the physicochemical analysis of oil extracted from cashew nut kernels in central Côte d'Ivoire. This study aims to enhance the value of these non-timber forest products by determining the physical and physicochemical properties of this oil for better industrial development.

2. MATERIALS AND METHODS

2.1. Plant material

The almonds, crushed using an agate mortar, were placed in a Wattman cartridge and the oil was continuously extracted in a Soxhlet for 3 hours (Figure 3). The oil samples obtained were kept for the various analyses.

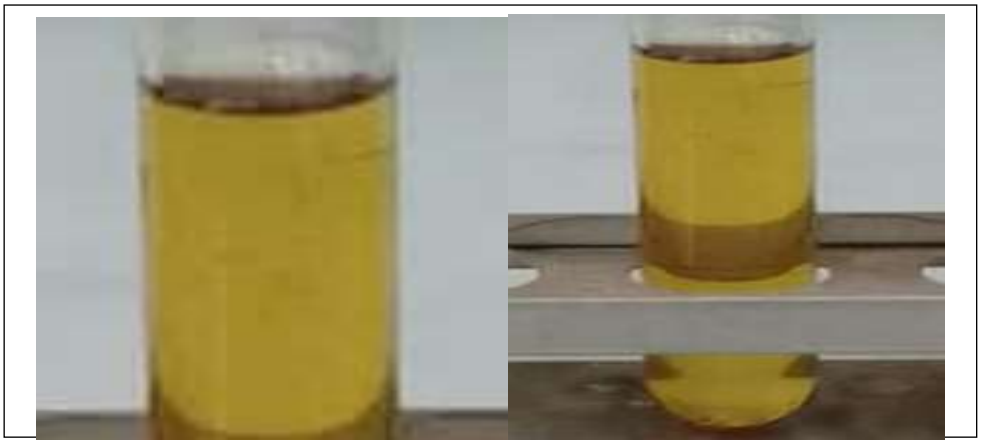

Figure 3: Oil extracted from cashew nut kernels.

2.2. Analytical methods

The analyses were repeated three times to determine the average of the parameters studied.

2.2.1. Determination of some physical parameters

2.2.1.1. Refractive index

The refractive index was measured using a digital refractometer (Leica AR 200 Barolworld). A volume of 2,5 mL of the oil was poured into the crucible of the apparatus, and the value of the refractive index was recorded after a few moments.

2.2.1.2. Density

The relative density of the oil was determined using a digital densimeter (Densito). A quantity of 2 mL of oil was poured into the tank of the apparatus to measure the density, and the operation was repeated three times.

2.2.1.3. Pigments

The determination of chlorophylls and carotenoids was carried out using an Ultra-Violet spectrophotometer. 7,5 g of MG were dissolved in 25 mL of cyclohexane. The absorbance (A) of the solution was read at 670 for chlorophylls and at 470 nm for carotenoids. The specific extinction coefficients used are E_0 = 613 for pheophytins and E_0 = 2000 for lutein, as the major components of the respective chlorophyll and carotenoid fractions (Guerfel, 2012).[10] The chlorophyll and carotenoid contents are calculated using the following expressions:

$$\text{Total chlorophylls}\left(\frac{\text{mg}}{\text{100g}}\right) = \frac{(A_{670} \times 25 \times 10000)}{(613 \times 7{,}5)}$$

$$\text{Total carotenoids}\left(\frac{\text{mg}}{\text{100g}}\right)=\frac{(A_{470}\times 25\times 10000)}{(2000\times 7,5)}$$

2.2.1.4. Specific extinctions K_{232} and K_{270} of fat

The extinction coefficients K_{232} and K_{270} of MG were defined according to Meftah et al., (2014).[11] 0,1 g of MG was taken up in 10 mL of cyclohexane. After homogenization, the specific extinctions (K_{232} and K_{270}) were measured at wavelengths 232 and 270 nm using the UV-vis spectrophotometer (JASCO 530). Cyclohexane was used as a reference. The specific extinctions were calculated as follows:

$$K_\lambda=\frac{A(\lambda)}{C\times S}$$

K_λ: specific extinction at wavelength λ; A(λ): Absorbance at wavelength λ; S: thickness of the tank (1cm); C: concentration of the solution to be analyzed (1g/100mL)

2.2.2. Determination of physicochemical parameters

2.2.2.1. Saponification index

In a ground-neck, flat-bottomed flask equipped with a condenser and containing 0,4 g of fat, 25 mL of alcoholic KOH (0,2 N) were added. The mixture was heated to reflux with continuous stirring for 1 hour. Then, 2 drops of phenolphthalein were added. The excess KOH was titrated hot with HCl (0,2 N) with constant stirring until the phenolphthalein discolored to obtain an equivalent volume (EV) (Bamba et al., 2015 and AFNOR, 1984).[12,13] A control without MG was assayed in parallel under the same conditions to obtain the equivalent volume (EV). The value of the saponification index is calculated according to the relationship:

$$I_S=\frac{N_{Hcl}(V_T-V_E)}{m}\times 56,1$$

Is: saponification index (mg/g); V_T: volume of HCl in the control test (mL); V_E: volume of HCl required to neutralize excess KOH (mL); N: normality of HCl; m: mass of MG (g); 56,1: molecular mass of KOH (g/mol).

2.2.2.2. Acid number

In a 250 mL Erlenmeyer flask containing 0,4 g of MG, 10 mL of alcoholic KOH (0.2 N) and 2 drops of phenolphthalein are added. The mixture is stirred for 3 minutes and then titrated with HCl (0,2 N) until the indicator remains discolored. A control, without MG, is measured

in parallel under the same conditions (AFNOR, 1984; Mamyrbekova-Békro, 2009).[14,15] The acid number is calculated according to the relationship:

$$I_a = \frac{N_{Hcl}(V_T - V_E)}{m} \times 56,1$$

Ia: acid number (mg/g); N: normality of HCl; V_E: volume of HCl (mL); V_T: volume of KOH (mL); m: mass of MG (g); 56,1: molecular molar mass of KOH (g/mol).

2.2.2.3. Peroxide value

In a ground-neck Erlenmeyer flask, 0,5 g of MG were dissolved in 25 mL of a mixture of anhydrous solvents [15 mL of acetic acid (AcOH) + 10 mL of chloroform ($CHCl_3$)] and 1 mL of saturated KI (14 g of KI in 8,5 mL of freshly boiled distilled water) was added. The Erlenmeyer flask was immediately capped, shaken manually and vigorously for exactly 60 seconds and then stored away from light for 5 minutes. Then, 70 mL of distilled water was added. The liberated iodine (I_2) was titrated with 0,005 N $Na_2S_2O_3$ with stirring until the color changed from orange-yellow to pale yellow. Then 1 to 5 mL of starch paste was added before continuing the titration until the color changed from purplish black to colorless, marking the end of the assay. A control assay was carried out in parallel under the same conditions [AOAC, 1997; Bamba, 2024].[16,17] The peroxide index is calculated using the expression:

$$I_P = \frac{(V_E - V_T) \times N \times 1000}{m}$$

Ip: peroxide index (méq of O_2/kg of oil); V_T: volume of $Na_2S_2O_3$ used to dose the control (mL); V_E: volume of $Na_2S_2O_3$ used to dose the sample to be analyzed (mL); N: normality of $Na_2S_2O_3$; m: mass of the oil (g).

2.2.2.4. Iodine value

The iodine value was determined according to the AOAC method, 1981[18] and Bamba, 2016[19] with some modification. In a ground-neck flask, 300 mg of MG were dissolved in 10 mL of chloroform ($CHCl_3$). 2 mL of the solution collected were introduced into a 250 mL Erlenmeyer flask. At the same time, 2 mL of $CHCl_3$ were introduced into another Erlenmeyer flask to perform the assay taken as a control. 2 mL of Wijs reagent were introduced into the Erlenmeyer flasks, which were left to stand protected from light for 1 h and then stirred from time to time. Afterwards, 6 mL of 10% (m/v) potassium iodide (KI) and 50 mL of distilled

water were added to each Erlenmeyer flask. Then the Erlenmeyer flasks were stirred for 5 minutes using a magnetic stirrer. Then, the liberated iodine (I_2) was determined by sodium thiosulfate ($Na_2S_2O_3$, 0,1 N), until the reaction mass turned pale yellow. At this time, 1 mL of starch paste was added and the determination was carried out until the blue color disappeared [AOAC, 1981].[18] The iodine value is calculated using the expression:

$$\mathbf{I_i = \frac{(V_T - V_E) \times 12,69 \times N}{m}}$$

Ii: iodine index (g of I_2/100 g); V_T: volume of $Na_2S_2O_3$ in the control test (mL);
V: volume of $Na_2S_2O_3$ required to neutralize excess I_2 (mL); m: mass of MG (g);
12,69: molar mass of I_2 multiplied by 100.10^{-3}; N: titer (0,1 mol/mL) of the $Na_2S_20_3$ solution.

2.2.2.5. Ester index

In practice, the ester index is deduced by taking the difference between the saponification index and the acid index (W. Batel, 1980, Bamba 2024)[20,17], according to the following formula:

$$Ie = Is - Ia$$

3.1. Physical parameters

The physical parameters of *Anacardium occidentale* oil from central Côte d'Ivoire are listed in Table 1.

The values of the specific extinction coefficients are 0,205 ± 0,012 for K_{270} and 2,510 ± 0,007 for K_{232}. They provide information on the presence or absence of secondary oxidation products in the fat. The values obtained for K_{270} and K_{232} almost meet the standard ($K_{270} \leq$ 0.25 and $K_{232} \leq 2.5$) (Bamba, 2016; Boulfane, 2015)[19,21], confirming that the extraction was done at low temperature (< 28°C). It is therefore essential to take precautions during extraction and storage.

Table 1: Some physical parameters of oil.

Parameters	Mean ± Standard Deviation
Density	0,901 ± 0,016
Refractive index	1,464 ± 0,025
K_{270}	0,205 ± 0,012
K_{232}	2,510 ± 0,007
Chlorophylls 670 nm	1,118 ± 0,011
Carotenoids 470 nm	0,890 ± 0,008

The refractive index of *Anacardium occidentale* oil is around 1,464 ± 0,025, comparable to that of some other vegetable oils such as cottonseed oil (1,470), peanut oil (1,470) (Aïssa, 2009)[22], olive oil (1,4703) (Ali and El-Waseif, 2009)[23] and Jatropha curcas (1,468) (ST Djenontin, 2006).[24] The density of a fat indicates the presence of foreign bodies. The density of *Anacardium occidentale* seed oil (0,901 ± 0,016) is close to that of well-known edible oils: olive (0,914-0,918), soybean (0,919-0,925), sunflower (0,918-0,923) and rapeseed (0,916) (ST Djenontin, 2006).[24]

3.2. Physicochemical parameters

The determined physicochemical parameters are reported in Table 2.

The saponification index of *Anacardium occidentale* oil from central Côte d'Ivoire is 391,297 ± 0,461 mg KOH/g of oil (Table 2). This value is higher than that of some edible oils, such as soybean oil (189 - 195 mg/g), peanut oil (187-196 mg/g), cottonseed oil (189-198 mg/g), olive oil (184 -196 mg/g) (Katou, 2017).[25] Compared to non-edible oils from Côte d'Ivoire, such as *Irvingia gabonesis* (211.30 mg KOH/g) [Bamba, 2024][17], *Myrianthus arboreus* (171,105 mg KOH/g) [Katou, 2017][25] and *Carapa procera* (192.68 mg KOH/g) (Diby, 2020)[26], the Is value is significantly higher. It also surpasses the saponification index of coconut (248-265 mg/g) and palm kernel (230-254 mg/g) oils commonly used in soap making (Food Codex, 2005).[27] This value indicates that the oil of *Anacardium occidentale* from the center of Côte d'Ivoire contains triacylglycerols with a higher molecular weight, due to its Is > 200 mg KOH/g, which would favor its use in fields such as cosmetology [Fatima, 2013].[28] Such an oil could be used in soap making.

Table 2: Physicochemical characteristics of *Anacardium occidentale* oil.

Parameters	Mean± Standard deviation
Saponification index (*Is*)	391,297 ± 0,461
Acid index (*Ia*)	9,537 ± 0,252
Peroxide value (*Ip*)	5,133 ± 0,090
Indice d'iode (*Ii*)	90,691 ± 0,743
Iodine index (*Ie*)	381,760 ± 1,029

The acid index is a good indicator of the stability and purity of an oil, determining its alteration. A low acidity value indicates the stability and purity of an oil (Tchiégang-Megueni, 2003).[29] The oil extracted from the seeds of *Anacardium occidentale* has a relatively high content of free fatty acids (9,537 ± 0,252) (Table 2). This value is above the standard for an edible oil (< 4 mg KOH/g) (Codex alimentarius, 1993).[30] Ia of the oil studied

is higher than that of well-known edible oils such as coconut (4-7), palm kernel (4,7), peanut (6) and soybean (7) oils (M'Baye, 2011).[31]

The peroxide value (I_P) is essential to assess the early stages of oxidative deterioration of an oil. For *Anacardium occidentale* oil, the peroxide value obtained is 5,133 ± 0,090 O_2/kg (Table 2), a relatively low value and lower than the limit of 10 meq O_2/kg required for most conventional oils (Codex, 1993; Codex, 2001; Codex, 2009).[30,32,33] This index allows to assess the level of primary oxidation of an oil by oxygen. The low value of Ip can be explained by the presence of natural antioxidant substances such as polyphenols, carotenoids in *Anacardium occidentale* oil. Ip of the oil studied is lower than that of extra virgin olive (10-20) (Tanouti, 2011)[34] and shea butter (14,5 -17,5) (Chatigre, 1998).[35]

The iodine index (Ii) of a lipid corresponds to the mass of I2 expressed in mg that binds to the double bonds of fatty acids in 100 g of sample. This index measures the degree of unsaturation of fatty acids. The iodine index of the oil analyzed is 90,691 ± 0,743 g of iodine/100 g of oil (Table 2). This indicates that *Anacardium occidentale* oil is rich in moderately unsaturated fatty acids (Kpoviessi, 2004).[36] Its composition in unsaturated fatty acids is comparable to that of olive oil, whose iodine index varies between 75 and 94 (M'Baye, 2011).[31] In addition, an iodine index greater than 90 suggests a richness in unsaturated fatty acids. (S. Bamba, 2016).[19]

The ester index of a fat is defined as the number of milligrams of potassium hydroxide (KOH) required to neutralize the acids released by the hydrolysis of the esters contained in 1g of fat. It is identical to the saponification index for pure glycerides. For oil extracted from *Anacardium occidentale* from central Côte d'Ivoire, the value obtained is 381,760 ± 1,029 mg KOH/g of oil. This value, different from the saponification index (391,297 ± 0,461 mg KOH/g), indicates a significant quantity of free fatty acids in the oil. It is therefore necessary to take pre-refining and packaging precautions to limit subsequent denaturation that could lead to discoloration of the oil.

4. CONCLUSION

The objective of this study was to assess the quality of oil extracted from cashew nuts (*Anacardium occidentale*), from central Côte d'Ivoire through an analysis of physical and physicochemical parameters. Almost all of the parameters determined comply with the Codex Alimentarius standards, indicating acceptable quality. The pigment contents (chlorophylls

and carotenoids) give this oil interesting pharmacological and nutritional qualities. However, the high acid index indicates that it is necessary to take pre-refining and packaging precautions to limit the degradation of the chemical and functional quality of the oil. Finally, additional work is needed to better understand the chemical composition in fatty acids and the toxicity of *Anacardium occidentale* oil, in order to promote its valorization in the food sector.

REFERENCES

1. Lautié E.M., Dornier F, De Souza M. and M. Reynes. "Les produits de l'anacardier: caractéristiques, voies de valorisation et marchés.'' Fruits, 2001; 56: 235-248.
2. Dugué P. 2002. Dynamiques de plantation et durabilité des systèmes de cultures pérennes en zone de savane de Côte d'Ivoire. Communication à la conférence internationale sur l'avenir des cultures pérennes. Yamoussoukro, 5-9 nov 2001. CIAD/ESI-VI, BNETD, 144.
3. Kone S. Diagnostic des systèmes de production à base d'anacardiers. Yamoussoukro, Côte d'Ivoire: ESA et FIRCA, 2014.
4. Banque Mondiale. Situation économique en Côte d'Ivoire. Banque Mondiale, Abidjan, Côte d'Ivoire, 2015.
5. Eugène Ucciani. Nouveau dictionnaire des Huiles Végétales. Paris : Lavoisier TEC&DOC, 1995.
6. JL Pousset. Plantes Médicinales d'Afrique. Comment les reconnaitre et les utiliser; Edisud, 2004; 284.
7. Katou YS, Yapo YCV, Konan GKNA, N'Da KP, Koffi NE. Biochemical and nutritional analyzes of almonds from *Anacardium occidentale* nuts (Anacardiaceae) from Côte d'Ivoire. International journal of advanced research (IJAR), 2023; 11(11): 942-947.
8. Katou Yapo Séverin, N'Guessan Patrick Audrey, Diby Allah Léonard, Mouho Guéi Didier Roselin, Bamba Souleymane and Koffi N'Dri Emmanuel. Determination of the Content of Polyphenols, Flavonoids, Tannins, Mineral Elements and Antioxidant Activity of Obtained from Cashew Nuts (*Anacardium occidentale*, Anacardiaceae) from Center Côte d'Ivoire. Asian Journal of Chemical Sciences, 2024; 14(6): 1-9.
9. Soro D. Concentration par microfiltration tangentielle et caractérisation d'extraits carotenoides de pomme de cajou. Institut des régions chaudes. Montpellier, SupAgro. Master Recherche Naval, 2008; 67.
10. Guerfel M., Mansour MB, Ouni Y, Guido F, Boujnah D, Zarrouk M. Chemical composition of virgin olive oils from the Chemlali cultivar with regard to the method of

the olive tree propagation. Journal grasas y aceites, 2012; 63(3): 290-295.

11. Meftah H, Latrache H, Hamadi H, Zahir H & M Louali. Comparaison des caractéristiques physicochimiques des huiles d'olives issues de différentes zones de la region Tadla Azilal (Maroc). Journal of Materials and Environment Science, 2014; 5(2): 641-646.
12. Bamba S., Mamyrbekova-Békro J.A., Virieux D., Kabran G.R.M., Pirat J.-L. and Bekro Y.-A. Analysis of a Rutaceae fat matter from Côte d'Ivoire. Der Chemica Sinica, 2015; 6(4): 47-50.
13. AFNOR (Association Française pour la Normalisation). Recueil des normes françaises: corps gras, graines oléagineuses et produits dérivés (3e eds.). AFNOR : Paris, 1984; 459.
14. Mamyrbekova-bekro J.A., Bamba S., Akaffou S. & Bekro Y.A. Caractéristique de la matière grasse extraite des amandes de *Afzelia Africana* (Fabaceae-caesalpinioideae) de Côte d'Ivoire. Rev. Ivoir.sci. Technol, 2009; 13: 191-198.
15. AOAC, Peroxide value using chloroform official method Cd-8-53. In official methods and recommended practices of the American oil chemist society. 4th edn, 1997.
16. Bamba Souleymane, Ouattara Logopho Hyacinthe, Tigoli Mougo André, Traoré Lanciné, Katou Yapo Séverin, Gué Alexis, Kabran Guy Roger Mida. Chemical and physico-chemical parameters of the lipid fraction of *Irvingia gabonensis* (Irvingiaceae). Journal of Chemical, Biological and Physical Sciences, 2024; 14(1): 094-100.
17. AOAC, Official methods of analysis 30th edn, Arlington, 1980.
18. Bamba S., Kabran G.R.M., Mamyrbékova-Békro J.A., Virieux D., Pirat J-L., & Békro Y-A., 2016. - Chemical survey of *Afraegle paniculata* fruit seeds from Côte d'Ivoire. Asian Journal of Plant Science and Research, 2016; 6(1): 35-40.
19. W. Batel, M. Grael, G.L. Meyer, R. Moller, F. Schoedder, Pflonzenole fur die kraftstoff- und energieversorgung. Grundlager der landtechnik, 1980; 30: 40-51.
20. Boulfane S., maata N., Anouar A. & hilali S. Caractérisation physicochimique des huiles d'olive produites dans les huileries traditionnelles de la région de la Chaouia-Maroc. Journal of Applied Biosciences, 2015; 87: 8022-8029.
21. Aïssa VM, Soumanou MM, Tchobo FP, Kiki D. Etude comparative de la qualité des huiles végétales alimentaires raffinées en usage au Bénin. Bulletin d'Informations de la Société Ouest Africaine de Chimie, 2009; 6: 25-37.
22. Ali HE, El-Waseif MA. Effect of Treated Olive Fruit by Some Growth Regulatorq on Physiochemical properties of Extracted Olive Oil. Curr. Sci. Int., 2015; 4(1): 105-116.
23. Djenontin ST, Dangou J, Wotto DV, Sohounlhoue KCD, Lozano P, Pioch D. Composition en acides gras, sterols et tocopherols de l'huile vegetale non conventionnelle

extraite des graines de *jatropha curcas* (euphorbiaceae) du benin, J. Soc. Ouest-Afr. Chim., 2006; 022: 59–67.

24. Katou YS, Mamyrbekova-bekro JA, Bamba S, Konan KM, Akaffou DS, Bekro Y-A. Physicochemical Analysis and Charaterization of the Lipid Fraction from Côte d'Ivoire *Myrianthus arboreus* (Cecropiaceae) Seeds. Asian Journal of Plant Sciences and Research, 2017; 7(1): 16-22.
25. Leonard AD, Luc AKD, Georges GT, Severin YK, Philippe KN. Physicochemical Characterisation and Fatty Acid Profile of *Carapa Procera* Vegetable Oil From Côte d'Ivoire. International Journal of Innovative Science, Engineering & Technology, 2021; 8(9): 138-148.
26. Codex alimentarius. Standard for vegetable oils Named, Codex-stan 210-1999. 2005; 17.
27. Fatima EE, Hamza MEI, Chakir EG, Mohammed S, Hcham H, Mohamed T. Effet du procédé d'extraction sur la qualité de l'huile des graines d'Asphodelus tenuifolius. OCL, 2013; 20-30.
28. Tchiégang-Meguéni C. Variabilité des caractéristiques physico-chimiques des huiles extraites des amandes Balanites aegyptiaca L. Del. En provenance du Cameroun et du Tchad. Procédé Biologiques alimentaires, 2003; 1(1): 11.
29. Codex Alimentaire Commission. Graisse et huiles Végétales, division 11, Version abrégée FAO/WHO. Codex Stan, 1993; 20-1981; 23-1981.
30. M'baye B.K. Quelques propriétés physico-chimiques d'une huile de *Balanites aegyptiaca* (dattes du désert) fabriquée et consommée en Mauritanie. Science Lib Editions Mersenne, 2011; 3: 2111.
31. Codex alimentarius. Programme mixte FAO/OMS sur les normes alimentaires, FAO, 00100 Rome (Italie). CL 2001/4-FAO. 2001.
32. Codex alimentarius. Normes alimentaires Internationales pour les huiles végétales portant un nom spécifique CODEX STAN 210-1999. Adoptée en 1999. Amendement: 2005, 2011, 2013, 2015. Révision : 2001, 2003, 2009. CODEX ALIMENTARIUS. 2009.
33. Tanouti K., Serghini-Caid H., Chaieb E., Benali A., Harkous M. & Elamrani A. Amélioration qualitative d'huiles d'olive produites dans le Maroc oriental. Les technologies de laboratoire, 2011; 6(22): 1-12.
34. Chatigre K.O. Caractérisation physico-chimique, biochimique et potentialité d'utilisation de la matière grasse des graines de *Canarium schweinfurthii* EngI. Thèse de doctorat de 3ème cycle, Université de Cocody, Côte d'Ivoire, 1998; 147.
35. Kpoviessi D.S.S., Accrombessi G.C., Kossouoh C., Soumanou M.M. & Moudachirou M.,

(2004).- Propriétés physico-chimiques et composition de l'huile non conventionnelle de pourghère (Jatropha curcas) de différentes régions du Bénin. Compte Rendus Chimie, 2004; 7: 1007-101.